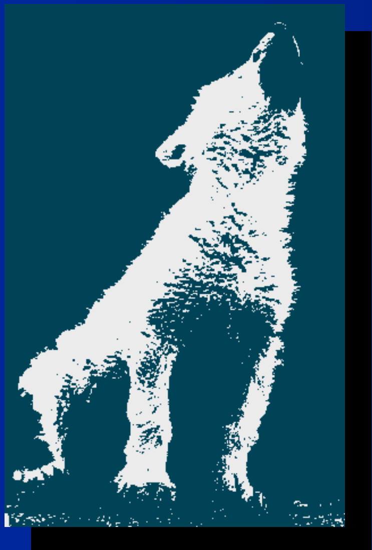


Gaelic Wolf Outdoors

Hypothermia

Nature’s Silent Killer of the Unprepared

Warning and Disclaimer

- This presentation is designed to be used in conjunction with training courses given by medical personnel with experience in outdoor emergency medical response providing training in this subject.
- Since the knowledge and expertise of such trainers cannot be gauged by the Gaelic Wolf Outdoors team, we cannot accept responsibility for the quality of training given in conjunction with this presentation set.

Many of the photographs used here were taken by David Bassett in his travels through the North American West and Northwest, and are being used with his permission.

More of David’s work can be seen on his WWW site at:

http://www.et.byu/~bassettd

What is it?

Hypothermia is a silent killer of those who are not prepared to face a cool, wet day.

It happens when your body is not able to make enough heat to replace the warmth you lose to the environment around you.

REMEMBER THIS:

If left untreated, hypothermia can kill.

Nobody ever froze to death — instead, they died of hypothermia.

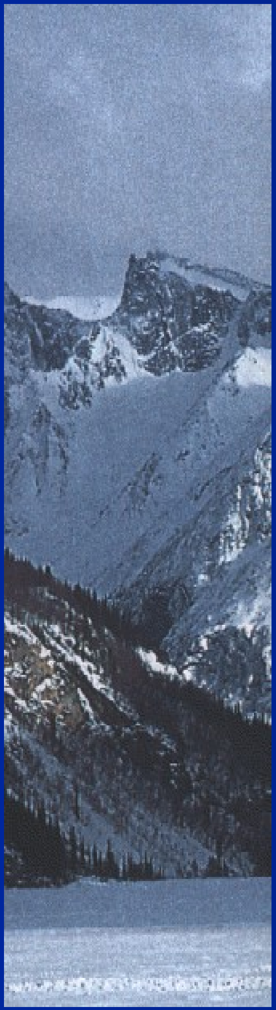
The freezing part came later...

...and only if the temperature of the surrounding environment was below freezing.

Technically Speaking

- Hypothermia is a medical condition that results from the body's inability to adequately replace heat lost to the surrounding environment.
- It is a progressive condition that can be reversed with appropriate care in the field.

YOU have had it before!



Have you ever felt cold?

Did you begin to shiver?

Did you shiver so hard that you couldn’t stop the shaking?

YES?

Those were the early stages of hypothermia!

The 1964 Four Inns Walk

- Annual competitive hike over English moorlands — 45 miles (73 km) long
- 1964 featured heavy rain, winds of 30 mph (48 km/h), 32º-45ºF (0º-7ºC) temperatures
- 240 experienced hikers started the day, 22 finished (usually about 2/3 finish)
- Three died of hypothermia, four rescued in critical condition

Four Inns Lessons

- Clothing typically provided less than 40% of the insulation the hikers required
- Most hikers took in 1000-1500 kilocalories (Cal) against a need of 6000 Cal
- All hikers had been selected for experience and top physical condition...
- ...but most were unable to maintain a high enough energy level to produce enough heat to keep adequately warm

What’s Next?

A short terminology review

How your body maintains its temperature

Avoiding hypothermia in the first place

How your body responds to cooling

Knowing how to recognize hypothermia

How to treat hypothermia

Immersion hypothermia — different from land hypothermia...

Terms to Know

- CORE — Central organs of the body, most importantly the heart, lungs, liver, brain
- DISTAL — Away from the body's center
- HYPOTHERMIA — Lower than normal core temperature
- HYPOTHERMIC — Having a lower than normal core temperature
- HYPOXIA — Condition resulting from a lack of oxygen circulating in the body

More Terminology

HYPOXIC — Having reduced oxygen levels in circulation

NORMOTHERMIC — Having a normal core temperature

PERIPHERY — “Outer” tissues and body parts, such as skin and all the tissues of the arms and legs

PROXIMAL — Closer to the body’s center

Last of the Terminology

VASOCONSTRICTION — Constriction or "narrowing" of the blood vessels

VASODILATATION — Dilation or expansion of the blood vessels

Note: When discussing vasoconstriction and vasodilatation in relation to how they play a part in hypothermia, we are talking mostly about the blood vessels in the periphery

Normal Body Temperature

- Average oral temperature 98.6ºF (37ºC)
- Normal range is from 96.5ºF (35.8ºC) to 100ºF (37.8ºC)
- Varies 1¼º - 3¾ºF (0.7º - 2.1ºC) during any given 24 hour period
- Lowest in early morning hours, highest in late afternoon or early evening
- Average variation 2.7ºF (1.5ºC) for men and 2.2ºF (0.5ºC) for women

Exercise Body Temperature

- Prolonged, heavy exercise can commonly cause the body temperature to rise as high as 104ºF (40ºC)
- If heat dissipation (by sweating) is impaired, higher temperatures and their related heat illnesses (such as heat stroke) may occur...
- ...even if the weather is cold

Controlling Body Temperature

- Physiologic responses — controlled by the brain (involuntary, such as shivering and vasoconstriction)
- Deliberate actions — (such as exerting yourself or putting on layers of clothing to retain heat when you stop exercising)

Hypothermia Weather

It’s cold. It’s wet. I wish I was just about anywhere else. I sure as heck didn’t sign on for this!

The weather doesn’t have to be freezing for you to get hypothermia. A 50°F (10°C) day with wind and rain will do just fine, thank you very much!

Part of preventing hypothermia is knowing how your body works, and how to protect yourself from the weather. Read on!

Responding to the Cold Environment

- The amount of heat you can generate through metabolism and exercise is minimal in comparison to the rate you will lose heat in a cold environment
- You have to prevent heat loss
- Unrelieved cold water immersion or low air temperatures and wind without adequate protective clothing usually results in lethal hypothermia

Physiologic Heat Loss

- Heat is generated in the muscles and by metabolic chemical reactions (mainly in the liver)
- About 90 - 95% of this heat is lost through the skin
- Some heat is lost through the lungs
- Heat is transferred from where it is being produced to the skin by warming the blood as it circulates through

Physiologic Heat Loss (con’t)

- Peripheral blood vessels dilate or constrict to control blood flow and determine rate of heat loss.
- Blood flow through fully dilated vessels is about 100 times greater than through completely constricted blood vessels
- Amount of heat transported is affected by the body’s total blood volume

Physiologic Heat Loss (con’t)

- Heat loss rates are greatly increased by sweating, especially in dry environments
- Vasoconstriction is the most significant physiologic heat loss control mechanism
- Peripheral vasoconstriction allows a cool outer “shell” to form — an insulating barrier that slows heat loss from the body core

Involuntary Change in Heat Production (Shivering)

- Involuntary shivering begins in response to a drop in the body core temperature
- Heat production roughly equal to that of a brisk walking pace
- DANGER! — Shivering usually stops once the core temperature drops below 90º - 92ºF (30º - 31ºC)
- DANGER! — Warming the skin of someone with hypothermia may stop the shivering, even though the core temperature hasn’t changed.

Shivering (con’t)

- Much more heat is produced by performing useful work, such as hiking out of the threatening environment to shelter
- Shivering brings several hazards caused by its interference with co-ordination
- Alcohol, some medications, low blood sugar, and exercising to exhaustion all hasten development of hypothermia by interfering with the ability to shiver

Your "Thermostats"

- Dominant control is exerted by a control center in the brain called the hypothalmus
  - Located at the base of the brain
    - Anterior portion of the hypothalmus is the "heat loss center"
    - Posterior portion of the hypothalmus controls heat retention
- A secondary control function takes part in the skin (cutaneous control mechanisms)

Information Sources

- Temperature of the blood circulating through the hypothalmus
- Impulses from nerves in the skin
- Information from both generally integrated to initiate a physiologic response
- However, there are exceptions...
  - Cold water immersion results in shivering before core temperature drops
  - Shivering stops as soon as the skin is warmed, even if the core temperature is still dropping

Cold Adaptation

- Homo Sapiens is a tropical animal
- Peoples who live in cold environments have adapted to their environment over time, and have an increased cold tolerance
- People who grow up in temperate climates do not “cold-adapt” to a point where they can gain anything like a significantly increased resistance to hypothermia
- We have to carry our tropical environment with us wherever we go (clothing)

Cold Vasodilatation — the "Hunting Reaction"

- When hands are immersed in water cold enough to cause tissue damage, blood vessels constrict to preserve heat
- Every 7-15 minutes the vessels dilate, especially in fingers, warming the tissues
- Prevents hand and finger disabilities
- Trade-off is a temporary increase in the rate of heat loss, especially problematic in full-body cold water immersion

Best Option? PREVENTION!

- You have to prepare yourself for the worst the environment can throw at you if you don’t want to have hypothermia
- There are two things you can do:
  - — Reduce heat loss
  - — Increase heat production
- Easy concepts to remember, right?
- They won’t help you if you don’t apply them, though...

Environmental Heat Loss

- We lose heat to the environment in four ways:
- Convection, conduction, evaporation, and radiation
- In comfortable environments, about 65% is lost by radiation, with most of the rest lost through evaporation
- In cold environments, most of your heat is lost by convection and conduction

Convection

- Happens when air or water with a lower temperature than the body comes into contact with the skin and then moves on
- You use convection when you blow on hot food or liquids to cool them
- Amount of heat lost depends on the temperature difference between your body and the environment, plus the speed with which the air or water is moving

Convection (con't)

- If you are not moving, and the air is still, you can tolerate a cold environment quite well
- Air in motion takes away a LOT of heat
- With air in motion, the amount of heat lost increases as a square of the wind's speed
- A breeze of 8 mph (12.8 km/h) will take away FOUR times as much heat as a breeze of 4 mph (6.4 km/h)

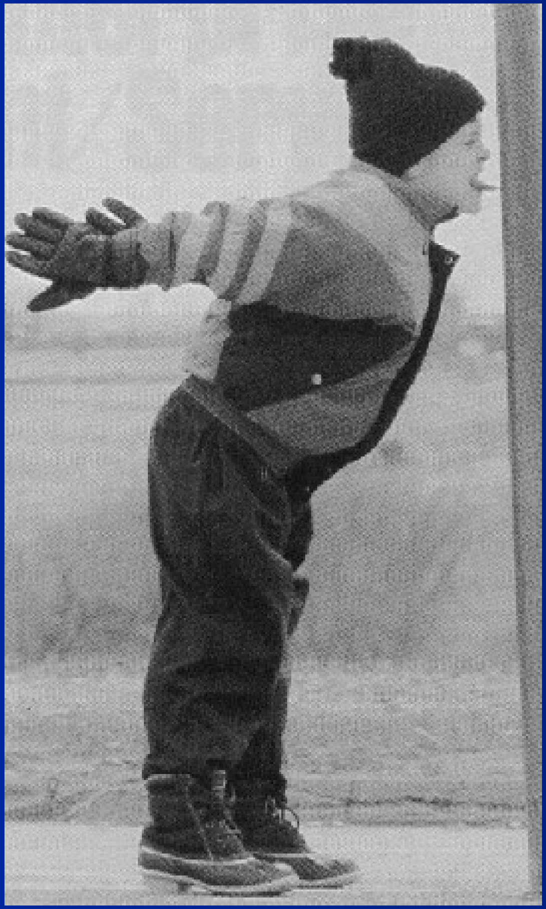
Convection (con’t)

- Above wind speeds of 30 mph (48 km/h), the point becomes moot, because the air does not stay in contact with the body long enough to be warmed to skin temperature
- Convective cooling is much more rapid in cold water because the amount of heat needed to warm the water is far greater than the amount of heat needed to heat the same volume of air

Conduction

- Transfer of heat away from the body to objects or substances it comes into contact with
- This is the one where grabbing a door handle with a moist hand at -40º gives you a chance to stick around...
- Stones and ice are good heat conductors, which is why you get cold when you sit on them

Conduction (con’t)



- We knew you might need a chuckle, and we had one available to put here....
- Now — be honest — how many of you gave this a try on a dare when you were much younger and less wise than you are today?
- Do you know how to get the metal to let go of your tongue?
- A large-ish pot of warm water will do the trick
- Before you go in to get one, though, you really ought to tell the dare-ee not to kiss the pole in addition to the what he’s already done...
- Conductive heat loss in action!

Conduction (con’t)

- Air conducts heat poorly — still air is an excellent insulator
- Water conductivity is 240 times greater than that of dry air
- The ground is also a good heat conductor, which is why you need a foam pad or other insulating barrier under a sleeping bag if you want to stay warm overnight

Conduction (con’t)

- Alcohol is an excellent heat conductor that remains liquid well below the freezing temperature of water
- At very cold temperatures, drinking alcohol (ethanol) can result in flash-freezing of tissues inside the mouth
- If the back of the throat and the esophagus become frozen this way, the resulting injury is often lethal

Evaporation

- Responsible for 20% - 30% of heat loss in temperate conditions
- About $^2/_3$ of evaporative heat loss takes place from the skin in thermoneutral conditions
- Remaining evaporative heat loss happens in the lungs and airway
- In cold weather, airway evaporative heat loss increases as the incoming air is humidified and warmed

Evaporation (con’t)

- In cold weather, 3 - 4 liters of water per day are required to humidify inhaled air
- 1500 - 2000 kilocalories (Cal) of heat are lost in this way on a cold day
- This fluid loss, if not replaced, results in dehydration, causing a lowered blood volume and increased risk of developing hypothermia

Evaporation (con’t)

- Wet clothing enhances heat loss
- Sweat-drenched clothing conducts heat toward surface layers of clothing
- Wet outer clothing layers enhance heat loss to the environment through evaporation
- A combination of sweat-soaked inner clothing layers and wet outer clothing can be quite lethal

Radiation

- Direct emission or absorption of heat
- Heat radiates from the body to the clothing, then from the clothing to the environment
- The greater the difference between body and environmental temperatures, the greater the rate of heat loss
- Clothing that adequately controls the rates of conductive and convective heat loss will compensate for the radiation heat loss

What to Wear?

- Clothing does not prevent very much of the radiation heat loss
- Only special-purpose vapor barrier clothing has much effect on evaporative heat loss
- In order to be considered adequate, cold and wet weather clothing needs to reduce or eliminate conductive and convective heat loss
- Adequate clothing traps layers of warm air next to your body

Layering

- Wear clothing in easily removed layers
- During warmer times of the day and while producing extra heat through exercise, remove outer layers
- DO NOT SWEAT! Sweat-dampened clothing loses much of its insulating abilities and increases your level of evaporative heat loss

Layering (con't)

- Remove gloves or mittens first, unless you need to wear them to protect yourself from conductive heat loss (handling cold tools, for instance)
- Neck-warmers and scarves should come off next, followed by headgear
- Open your jacket at waist and sleeves, followed by unzipping if still too warm

Layering (con’t)

- Finally, if you are still getting too warm, begin removing clothing layer by layer until you reach a level where you are comfortably warm without perspiring
- When you slow down or stop, you need to add layers back on in the reverse order
- Put layers back on before you start feeling cool or cold — otherwise, additional heat is needed to warm your body again

Layering (con’t)

- Something important to remember — Each layer of clothing needs to be slightly larger than the layer beneath it
- If most or all layers are the same size, they compress the still air space, causing a significant loss in the insulating value of the clothing
- PLAN IN ADVANCE! Make sure you pack the right sizes for your best protection

Clothing Materials

- Wool is an excellent choice. It is durable, and insulates well, retaining 80% of its dry insulation value even when dripping wet
- Down is the best insulator for its weight, but only when it is dry. Down loses almost all of its insulating value when it is wet
  - Down is the filler of choice for sleeping bags and outer clothing in areas where relatively dry snow is the main precipitation — most typically at high altitudes

Clothing Materials (con’t)

- Polyester fibers are used as substitutes for down in wetter climates. They retain much of their insulating value when wet, but are heavier
- Polyester insulating fiber materials, such as Polarguard® or Qualofil® are constantly improving, with new products becoming available

Clothing Materials (con’t)

- Polypropylene is being used for fabrics such as Polar Fleece® that retain much of their insulating qualities when wet
- Needs to be laundered frequently, because it retains body odor
- Has a disturbing (especially after you have spent a lot of money) tendency to melt if dried by itself in a dryer on high heat...

Clothing Materials (con’t)

- Vapor barrier systems are multi-layered fabrics that contain an impermeable layer bonded to one or more layers of other types of fabrics
- Designed to retard evaporation of moisture from insensible perspiration and slow evaporative heat loss
- Used in extreme cold weather sleeping bags and socks, for the most part

Clothing Materials (con't)

- Moisture often collects between the vapor barrier and the body
- If used in weather that is not extremely cold, so much moisture can collect beneath the barrier layer that overall protection from cold is significantly reduced
- Vapor barrier systems are most beneficial in extreme cold weather situations

A Word About Jeans...

- Cotton denim is just about the WORST fabric you can wear in wet weather
- If the cuffs of your jeans are out where they can get wet, the wicking action of cotton carries the water upwards
- Wet cotton denim in a breeze will transport heat away from your body as much as 240 times as rapidly as dry skin in calm air
- The fashion statement that can kill...

Keeping Hands Warm

- The body’s first response to cold is to constrict the peripheral blood vessels, which means that fingers feel cold sooner than most other body parts
- Fingers are small cylinders, and mittens are the best way to keep them warm
- ¼ inch (0.6 cm) of insulation in a glove finger is the most protection you can add; thicker glove fingers won’t keep your fingers any warmer

Hand-warming (con’t)

Best protection for hands is provided by a three layer combination:

1 — A thin inner glove made of silk or nylon

2 — A thick inner mitten made with wool, down, or other good insulating material

3 — An outer windproof, water-repellent shell mitten with cuffs that seal about mid-way up the forearm

Is your hat rack warm?

- The brain is very selfish — it demands heat, and it will steal it from anywhere else in the body
- The skull is near the surface, and conducts heat as readily as any other hard material
- The scalp is very thin, and richly supplied with blood vessels
- If you want your body to be warm, you have to keep your head covered

Headgear

- A wool hat is the best readily available option — those with a synthetic liner help keep the “itchies” at bay
- Polypropylene hats also insulate quite well
- The hat needs to cover the scalp, ears, and the back of the neck to prevent heat loss adequately
- Hoods are less effective, since they do not fit as snugly as a good hat

Underwear

- “Long-johns” need to maintain a layer of insulation next to the skin, even when wet
- Wool and polypropylene are the two best materials for meeting this goal
- Wool is less expensive, and provides more warmth for equal weight — however, many people are sensitive to wool in contact with their skin

Rain Gear

- Your clothing needs to be kept dry — wet clothing loses most, if not all, of its ability to help you retain your body heat
- Good raingear has two properties:
  - It keeps out the rain
  - It “breathes”, allowing water vapor to escape
- There are no fabrics available that do both perfectly, although two types come close

Rain Gear (con’t)

- Laminates, such as Gore-Tex®, have two or more layers, one of which has pores large enough to allow water vapor to escape, but too small to allow liquids to penetrate
- Tightly woven rainwear fabrics that have very small pores or composite fabrics (one being cotton, which swells to fill pores) are actually water resistant, but will not stand up to heavy downpours

Rain Gear (con't)

Water repellent sprays can be used to increase weather resistance of fabrics, but they are no substitute for high quality rain wear

There are numerous rain gear products that are made of completely waterproof materials, with vents to allow sweat to evaporate...

...But you *will* get wet from perspiration if you have to wear them more than a few minutes

A Word About Ponchos

Ponchos are waterproof, and can be worn loosely to allow perspiration to evaporate

If the wind is blowing, though, the poncho will:

1 — Flap around, and allow you to get wet

2 — The air pressure inside the poncho will be slightly lower than it is outside in the wind, and raindrops will be "sucked" up inside the poncho, making you still wetter

Rain Gear (con't)

- It is just as important to protect your lower body as it is your upper body
- Rain trousers should be made from the same material as the top garment
- However, impervious rain trousers are less of a risk than an impervious raincoat, because legs perspire less than the torso
- *DANGER!* Never wear jeans in the rain, either as an outer garment or under rain trousers

Rain Gear (con’t)

- A raincoat hood needs to be large enough to cover your head when you are wearing a cap, but needs to close snugly enough to keep water out
- Seams, especially at shoulders, tend to leak and need to be well-sealed — inspect frequently, re-sealing as often as needed
- Avoid raincoats with seams on top of the shoulders

Rain Gear (con’t)

- Zippers need to have a flap that will cover them, with fasteners to keep the zipper covered in any weather
- Pockets need to be covered with a flap that will keep water out
- Cuffs need to be closable with snaps or Velcro® because:
- Elastic cuffs ride up and can’t be adjusted
- Knit cuffs get wet and stay wet

Footwear

- The warmest boots we know of are the double vapor barrier military boots known as “Mickey Mouse” boots
- Composed of inner and outer rubberized layers, with insulation in between
- They have some disadvantages, though:
- Soft, floppy, little foot or ankle support
- Perspiration cannot escape — feet get wet and stay wet, even if they are warm

Footwear (con't)

- *DANGER!* Sports shoes, whether they are low or high-top are *NOT* suitable for use when hiking or backpacking at any time
- They are not waterproof or water-resistant, and do not offer adequate foot or ankle support
- These types of shoes are, however, light to carry, and are acceptable as "camp shoes", if you wish to bring them along

Footwear (con’t)

- Leather is the best material for boots
- It can be made hard enough to provide good foot and ankle support
- At the same time it can be made soft enough to be flexible
- It is porous enough to “breathe”, allowing moisture to pass through
- It can be made waterproof with a number of different products, such as Sno-Seal®

Footwear (con't)

- Leather boots are flexible enough to allow for the swelling you get in your feet after several hours of standing and walking
- Boots used in cold weather or very rough country should be constructed of all leather, with a soft lining
- Combination leather-fabric boots (with the best fabric most often being Gore-Tex®) are excellent for warmer weather use in less demanding terrain

Footwear (con't)

- Your boots need to be large enough to allow you to wear two pair of socks comfortably without feeling tight on your feet
- Boots that are too tight lose most of their insulating ability, increasing chances of cold injuries, such as frostbite
- Tight boots also compress superficial blood vessels, compromising circulation, which also increases risk of frostbite

Footwear (con't)

- If you are backpacking, you should bring along a pair of high-top "camp shoes" so that you can give your boots a chance to dry out at the end of the day
- Change to dry socks when you arrive, as long as you can keep your shoes dry
- Place the socks you remove into your boots, top first, so they can absorb moisture from the leather overnight

Footwear (con’t)

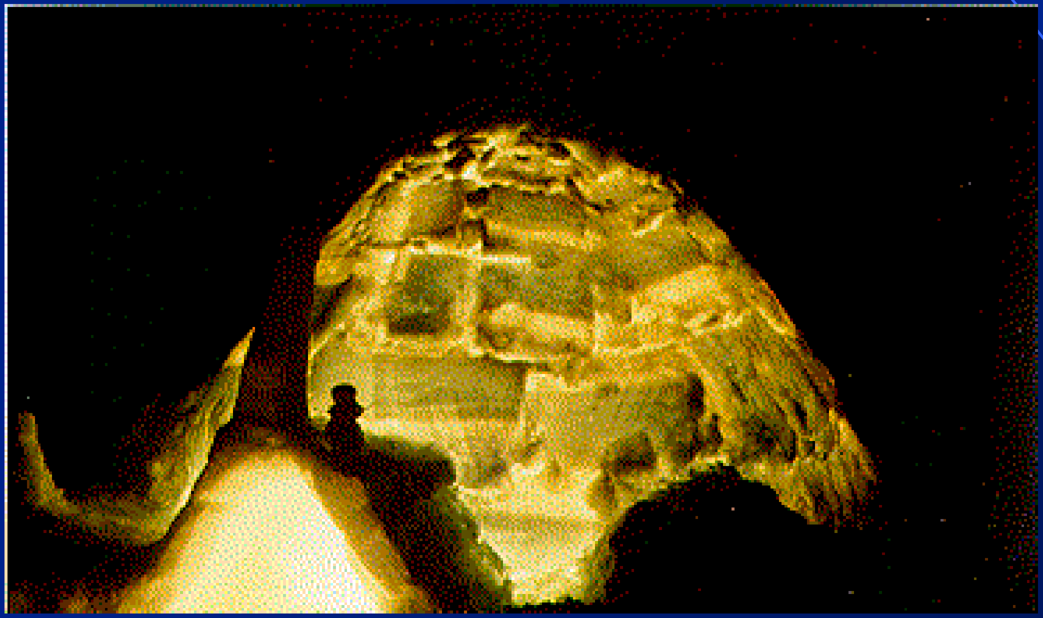
- You should wear an inner sock of cotton, which will “wick” moisture away from your feet
- Your pair of “oversocks” should be made of an absorbent material that will also keep your feet warm — wool is best
- For extremely wet weather, there are now Gore-Tex® socks available, which you can use as an additional layer, so long as they don’t make your boots fit too tightly

Gaiters

- Gaiters are sleeves that fit tightly to the outside of your boots and extend up the leg, usually to just below the knee
- Generally waterproofed fabric with a zip up the back
- Useful accessory that keeps snow out of your boots, water from the trouser cuffs
- Can give you a few extra seconds to get your feet out of the stream you step into

Shelter

Home, sweet home…



Shelter

- Temporary shelters, including tents, have to provide protection from the convective cooling effect of the wind
- Tents are not windproof, and need some kind of windbreak placed between them and the wind
- Well-constructed snow shelters are much more effective, since they are much more effective at blocking the wind

Shelter (con’t)

- Stationary air inside an effective shelter can be warmed by body heat for a more comfortable environment
- If your shelter is a natural cave with adequate ventilation, you can build a fire for warmth
- If you are in a snow shelter, and have built in good ventilation, you can use a small stove for heat, as well as for cooking

Shelter (con’t)

- If you use a tent in cold weather, you have to make certain the floor and lower walls are waterproof
- The inner walls of the tent must be able to “breathe” to allow exhaled moisture to escape
- You need an insulating pad between yourself and the ground or any shelter floor directly in contact with the ground

Shelter (con’t)

- Exhaled moisture freezes to the inside of tent walls — don’t brush up against them (especially when you are changing your innermost shirt...)
- The inner walls of snow shelters will have some melting until a thin layer of ice forms over the walls and ceiling — be sure to form your ceiling so that it doesn’t have any “drip points”

Your Body's Heat Production

- The only way to significantly increase your body's heat production is with exercise
- The large muscles of the leg produce more heat than smaller muscles elsewhere
- If you are in a situation that prevents your using those muscles to hike you out to a nice warm building, repeated exercise, such as stepping up and down a rock will produce far more heat than shivering

Heat Production (con't)

- The body produces heat as a by-product of the biochemical reactions that convert food to stored energy
- During physical activity, only about 20% of this energy is used for work — the rest is converted to heat
- Energy from metabolizing food is expressed in kilocalories (Cal), which are commonly erroneously referred to as "calories"

Heat Production (con’t)

- In everyday average activity most people require 1800-3000 Cal daily, depending on body mass and the type of work they do — with very physically demanding jobs requiring more
- Glucose is the major source of energy for the body, and is stored in the liver, muscles, and (to a lesser extent) in the blood

Heat Production (con't)

- Glucose is stored mainly in the form of glycogen
- The body's reserves are limited, adequate only for a few hours before needing to be replaced
- In cold weather, backwoods activities in poor weather may require 6000 Cal daily
- If you are depending on exercise-produced heat to avoid hypothermia, you need to consume large quantities of food

Heat Production (con’t)

- Experienced outdoors users have found that repeated small snacks in addition to at least three good meals a day will help keep hypothermia at bay indefinitely
- A balanced diet, with larger than usual quantities, is essential for the best possible health during outdoor activities
- Experience will teach you your personal best eating pattern and food preferences

Oxygen Consumption and Hypothermia

- O_2 consumption for a given level of work is greatly increased when the body's core temperature drops below normal
- At rest an average man consumes 0.2-0.33 liters of O_2 per minute (LO_2/min)
- Walking on level ground at 3 mph (5 km/h) consumes about 1.1 LO_2/min
- International class runners can achieve levels of 5.5 LO_2/min for a short time

Oxygen Consumption and Hypothermia (con’t)

- Mount Everest expedition climbers work at about 1.45 - 1.98 LO_2/min, with maximal consumption levels of 2.0 - 3.75 LO_2/min
- Consumption of 2.5 LO_2/min is about the same as producing 600 Cal/hour — or the same as trotting along at 6 mph (10 km/h)
- After a core temperature drop of only 1.1°F (0.62°C), with no work being performed, O_2 consumption increases by 360%

Oxygen Consumption and Hypothermia (con’t)

- Research shows that hikers spontaneously increase their pace whenever their skin temperature falls below comfortable levels
- The resulting pace has been known to exhaust the hikers to the point of near collapse
- Poorly conditioned hikers may not be able to maintain such energy expenditure levels long enough to get out of trouble

Physiologic Cooling Responses

- Human function is the end result of many complex chemical reactions
- Biochemical reaction times are extended when taking place at less than optimum temperatures
- Body functions become slower and less efficient
- Blood thickens when cooled
- Pliable materials, such as plastic, become stiff when cooled — so do muscles

Cooling Responses (con’t)

- Cold doesn’t affect all organ systems the same, but can cause one system to fail, bringing about failure in others
- Until core temperature reaches about 90°F (32°C) the response to cooling is mainly an effort to restore normal temperature
- Below 90°F (32°C) function becomes more and more abnormal as the core continues to cool

Cooling Responses (con’t)

- Mild cooling causes muscle stiffness and problems with coordination
- Oxygen consumption greatly increases, even when performing simple tasks
- Profound hypothermia slows nerve impulse transmission, compounding coordination problems
- Muscles lose the ability to contract or relax effectively

Cooling Responses (con’t)

- As cooling continues the victim’s muscle control deteriorates to the point where no useful work, even so much as zipping up a jacket, can be performed
- Profound hypothermia victims often can’t even assist in their own rescue
- Shivering tapers off or ceases as the core temperature falls through about 90°F (32°C), further reducing heat production

Cooling Responses (con’t)

- With mild cooling, thinking and the ability to make appropriate decisions begin to deteriorate
- Personality becomes disagreeable, with apathy and lack of cooperation
- As core temperature drops, impairment become more significant, with confusion, disorientation, and complete inability to make logical decisions

Cooling Responses (con’t)

- If still capable of coordinated movement, victims of extreme hypothermia often take off clothing
- Speech is slurred
- As core temperature continues to drop, lethargy and somnolence (drifting in and out of consciousness) progress to coma
- Loss of vision can occur just before coma

Cooling Responses (con't)

- One of the few good points of accidental hypothermia is that the cooled brain requires far less oxygen than it does at normal core temperatures
- In cold-water drowning, this often means successful resuscitation after extended periods of time under the water

Cooling Responses (con't)

- Assume that all hypothermia victims are severely dehydrated, with significantly reduced blood volumes
- Vital organs with inadequate blood supplies work less efficiently, compounding all the other problems that hypothermia causes
- As core temperature drops, the kidneys extract still more fluid as a result of what is known as "cold diuresis"

Cooling Responses (con't)

- As fluid levels drop, the peripheral blood vessels constrict even more than before, which forces cooler blood toward the body core
- This increases fluid pressure in the core, more antidiuretic hormone is released, resulting in still more urine production
- Finally, cold and reduced O_2 supply affect the kidneys, causing more water loss

Cooling Responses (con't)

- Blood volume is also reduced when core temperature drops because water leaves the blood and is held in body tissues
- Blood viscosity (thickness) is increased by as much as 175% through fluid loss and the direct effect of cold on the blood
- A core temperature drop also causes the spleen to contract, increasing the number of circulating red blood cells

Cooling Responses (con’t)

- People who have been exposed to several days of cold often have a reduction of as much as 25% in their blood volumes
- This, coupled with the constriction of the peripheral blood vessels, decreases the amount of oxygen transported to tissues
- Oxygen transfer at the cell level is also impaired because cold hemoglobin does not readily release its oxygen

Cooling Responses (con’t)

Diminished oxygen delivery is partially offset by two things:

Increased quantity of oxygen dissolved in the liquid part of the blood (19% more at a core temperature of 76°F (30°C))

Tissue acidosis increases the rate of oxygen release from the hemoglobin

Cooling Responses (con’t)

- In profound hypothermia, the heart beats slowly and weakly (the muscle tissue becomes weak and stiff)
- The amount of blood pumped with each beat is markedly decreased
- Impulse conduction is impaired, and the heart rate falls to as slow as 20 or less per minute

Cooling Responses (con’t)

- Electrical conduction becomes erratic, and the heartbeat can become irregular
- As the core temperature continues to fall, a fatal irregularity, ventricular fibrillation, can stop all circulation, causing the victim’s death
- Rough handling of a victim of severe hypothermia can trigger ventricular fibrillation

Cooling Responses (con’t)

- Surprisingly, a hypothermia victim usually has a normal blood pressure, although it may be hard to obtain a reading as a result of diminished blood flow in the arm
- Ventilation of the lungs is normal down to a core temperature of about 90°F (32°C)
- Below that temperature, carbon dioxide (CO_2) begins to build up in the blood, an indication of inadequate ventilation

Cooling Responses (con't)

As core temperature continues to drop, the brain becomes more unresponsive to the increasing CO_2 levels

Hypothermia can sometimes increase the secretion of mucus by membranes lining the major airway passages, while the cough reflex may be reduced, allowing a fluid build-up that can lead to problems

Cooling Responses (con’t)

During re-warming, the lungs may fill with fluid (pulmonary edema)

When autopsied, the lungs of people who have died after an episode of hypothermia always show various types of damage, including:

Breakdown of alveoli (air sacs)

Bleeding

Fluid accumulation (edema)

Pneumonia (secondary to hypothermia)

Cooling Responses (con’t)

- Cooling the liver slows biochemical activity, but doesn’t damage the organ
- Drug metabolism in the liver is impaired, though, with a medication’s effect often lasting much longer than normal
- Giving medications at the prescribed dose and times can lead to an inadvertent overdose

Cooling Responses (con't)

- Effectiveness of insulin for diabetics is reduced during hypothermia
- Increased blood glucose levels are not uncommon in hypothermia victims, even those who are not diabetics
- Despite the many changes that occur in body systems during hypothermia, hypothermia itself causes no permanent problems in an otherwise healthy person

Complications

While the risk of complications is low in healthy people, there are a few to be aware of

Most of these result from pre-existing health problems

1 — Pneumonia

2 — Acute pancreatitis

3 — Intravascular clots (thromboses) causing heart attacks or strokes

Complications (con't)

4 — Pulmonary edema

5 — Acute renal failure due to tubular necrosis

6 — Increased renal potassium excretion leading to alkalosis

7 — Hemolysis (breakdown of red blood cells)

8 — Depressed bone marrow function

Complications (con't)

9 — Inadequate blood clotting

10 — Low serum phosphorus

11 — Seizures

12 — Hematuria (blood in the urine)

13 — Myoglobinuria (muscle pigment that looks like blood in the urine)

14 — Simian deformity of the hand

15 — Temporary adrenal insufficiency

16 — Gastric erosion or ulceration

At Risk Situations

- On average the very young and the elderly are more likely to develop hypothermia
- The elderly may be malnourished or have debilitating diseases
- A room temperature of 60°F (16°C) may be inadequate to prevent chronic heat loss in an elderly individual
- Very young children have a proportionally greater body surface area, and will lose heat more rapidly than older children

At Risk Situations (con’t)

Alcoholics are one of the groups at highest risk for developing hypothermia because:

Excess alcohol interferes with shivering

Alcoholics are often malnourished

Heat loss rates are increased because alcohol dilates the peripheral blood vessels

Alcohol intake causes dehydration

At Risk Situations (con't)

- Unprotected immersion in water cooler than 60°-70°F (16°-21°C) places you at risk of developing hypothermia
- Injured people are more likely to develop hypothermia than healthy people due to shock or other complications caused by their injuries
- Hypothermia can develop rapidly if you are immobilized involuntarily or voluntarily

At Risk Situations (con't)

- Adverse weather conditions (high winds, low temperature, precipitation) set you up for hypothermia unless you are dressed adequately, are adequately hydrated, and have been taking in enough food
- All else being equal, you will survive longer on a 10°F (-12°C) day with sunshine and still air than you will on a 40°F (4°C) day with rain and wind

Recognizing Hypothermia

- Failure to recognize and treat hypothermia can have devastating consequences
- You need to watch both yourself and the people with you for the development of hypothermia signs and symptoms
- If one member of your group has obvious hypothermia, you can assume that other group members have milder forms of hypothermia

Mild Hypothermia

- The victim complains of feeling cold
- He or she is often wet...
- ...and is frequently shivering to some extent, though this may not be apparent while walking
- There is a loss of interest in any activity beyond getting warm, and a lot of negativity toward the group’s original goals

Mild Hypothermia (con’t)

- Problems begin to develop with muscular coordination, beginning with fine motor tasks in the hands
- The victim gradually becomes unable to keep up with the group and begins to have trouble walking over rough terrain
- As the core temperature continues to drop, stumbling becomes frequent, and he or she becomes clumsy with any task

Profound Hypothermia

- Defined as hypothermia with a core temperature of 90°F (32°C) or lower
- Characterized by altered mental function
- Carelessness about protecting self from the cold
- Thinking is slow; decision-making is difficult and often erroneous
- Memory for specific facts deteriorates

Profound Hypothermia (con't)

- The victim may have a desire to escape the situation by sleeping
- Lapses in willingness to survive; wants to give up and sit down
- As the core temperature deteriorates, periods of unresponsiveness alternate with periods of activity
- Begins to drift in and out of consciousness until lapsing into coma

Profound Hypothermia (con't)

- An abnormal behavior pattern that seems to be specific for profound hypothermia is the individual who appears willing to cooperate, but fails to do so
- Muscle function deteriorates in pace with declining mental function
- Shivering gradually decreases and finally stops at a core temperature of about 90°F (32°C), although this varies by individual

Profound Hypothermia (con’t)

- Problems with walking progress to difficulty with standing, and to becoming unable to do either
- Skin may feel cold and unpliable, and may be pale or slightly bluish (cyanotic)
- There may be evidence of frostbite
- There are no changes in the eye pupils
- Pulse is often weak and hard to feel, slow, and irregular

Profound Hypothermia (con't)

- Blood pressure is difficult to measure and is normal or (rarely) low
- Heart sounds may be diminished in intensity
- Breathing tends to be slow and shallow
- Lung sounds are usually clear, but *<u>may</u>* be changed due to fluid in the lungs
- Breath may smell fruity due to incomplete metabolism — this sign indicates a *<u>very</u>* serious situation

Profound Hypothermia (con’t)

Clothing may be soaked with urine

Five most common signs of hypothermia

1 — Mental changes

2 — Incoordination

3 — Cold skin

4 — Acetone odor on breath

5 — Urine-soaked clothing

Near Death

- Some victims of profound hypothermia have been pronounced dead before they really were
- Profound hypothermia can mimic death
- An ECG may be required to determine if there is any heart activity
- No one should be pronounced dead until they have been carefully rewarmed to near normal core temperature without successful resuscitation

Treating Hypothermia

- ***No previously healthy person should die of hypothermia after being rescued and having treatment started***
- Although no two cases of hypothermia are alike, the principles of case management are
- Acute immersion hypothermia and chronic exposure hypothermia are treated the same

Treating Mild Hypothermia

(Above 90°F (32°C))

- Protect from further cooling and rewarm by any convenient means
- If placed in a warm environment this group of hypothermia victims will rewarm with no complications
- If clothing is wet, it needs to be removed and replaced with dry clothing
- Warm (body temperature) liquids may be given by mouth, even though they have virtually no warming effect

Treating Mild Hypothermia
(con’t)

- Alcohol of any sort should not be given to any hypothermia victim
- Heat sources such as hot water bottles, heating pads, or warm stones may be used as external heat sources, and should be placed at points of least insulation (inguinal areas, trunk, neck)
- A second person in a sleeping bag can provide additional warmth

Treating Profound Hypothermia

- Mortality of hypothermia profound enough to produce coma varies from 50% - 80%, even with hospital care
- When death occurs during treatment, it is invariably due to ventricular fibrillation
- This VF virtually never reverts to normal spontaneously, and usually cannot be stopped, even with cardioversion, in severely hypothermic patients

Treating Profound Hypothermia (con't)

- The fundamental principle of care for deep hypothermia is to avoid ventricular fibrillation while slowly rewarming the patient
- There are many things that can trigger ventricular fibrillation (VF) in victims who have profound hypothermia
- Sudden exertion after long periods of being inactive can cause sudden death by VF

Treating Profound Hypothermia (con’t)

- When the victim moves after a long period of inactivity, the muscle action pumps cold blood back toward the heart
- This causes the temperature of the already cold-compromised heart to drop further, triggering ventricular fibrillation (VF)
- The victim with profound hypothermia must never exert himself — he must not walk, climb, swim, or even move when lifted

Treating Profound Hypothermia (con’t)

- Rescuers can trigger VF through rough handling of the hypothermia victim
- Manipulating the victim’s limbs can pump cold blood back toward the heart, which can reduce its temperature enough to trigger ventricular fibrillation
- Patients with profound hypothermia need to be handled as gently as they would if they had a spinal fracture instead

Treating Profound Hypothermia (con't)

- Rescue will be futile if not carried out very gently
- A hypothermia victim who has been cold for long enough to be in this situation suffers little adverse effect from the additional minutes involved in gentle handling
- Victims of profound hypothermia should not be re-warmed in the field unless there is no other alternative

Treating Profound Hypothermia (con’t)

- Rapid re-warming, by immersion in a warm water bath, can cause “rewarming shock” which is often lethal
- This can happen in profound hypothermia victims who are also severely dehydrated (a common combination)
- The warmth from the water causes blood vessels that were constricted to rapidly dilate

Treating Profound Hypothermia (con't)

- This results in a rapid fall in blood pressure and shock
- Cold, metabolically imbalanced blood is shifted to the heart, causing a further core temperature drop and sometimes triggering ventricular fibrillation
- Even though these mechanisms are not very well understood, their predictability has been observed too often to ignore

Treating Profound Hypothermia (con’t)

- Treatment with heated, humidified air or oxygen has received attention in recent years
- The technique can be useful, but has some limitations to keep in mind
- Most of the heat is carried in the water used to humidify the gasses
- The total amount of heat carried into the core is not very significant

Treating Profound Hypothermia (con't)

- Since profound hypothermia victims only breathe shallowly and slowly, the amount of overall heat exchange is further limited
- For heated oxygen therapy to be effective, the gasses need to be administered via an endotracheal (ET) tube...
- ...But inserting an ET tube can trigger our old enemy, ventricular fibrillation

Treating Profound Hypothermia (con’t)

- If the oxygen is being administered via a bag instead of a pressure demand valve, overventilation can occur, resulting in respiratory alkalosis, maybe leading to VF
- Rescuers may think they are providing more effective treatment than they really are, leading them to fail to provide better protection from the cold and more timely evacuation to hospital care

Treating Profound Hypothermia (con’t)

- Despite the limitations, systems that give heated, humidified air or oxygen are useful, though best employed in the hospital setting
- The system can prevent heat loss via the respiratory tract and add about 10 Cal / hr to the treatment process
- A calorie saved is a calorie that doesn’t have to be added later

Treating Profound Hypothermia (con’t)

1 — The victim must *NOT* be allowed to move

2 — Evaluate for open airway, breathing and circulation

3 — Examine the victim carefully for signs of any other injury or medical problem

4 — Remove from environment and prevent further heat loss by:

Treating Profound Hypothermia (con’t)

- Gently remove wet clothing and replace with dry clothing
- If you have a tent available, set it up — put the victim inside with other people (heat)
- Cover victim with any available sleeping bag, ground cloths, raincoats, blankets
- Head, neck, and trunk *must* be well covered
- Loosen boots and constricting garments
- Insulate the victim from the ground

Treating Profound Hypothermia (con't)

- Review the four mechanisms of heat loss (convection, conduction, radiation, and evaporation) to make sure you have not overlooked any way the victim can lose more heat
- If possible, build a fire — NEVER PLACE THE VICTIM CLOSE TO A FIRE! — The other members of the group will need its heat to prevent problems of their own

Treating Profound Hypothermia (con't)

5 — Plan and set up a definitive camp

If possible, move any other original camp to where the victim is

If the camp cannot be set up where you are, locate a safe, sheltered site very nearby

Once the new camp is set up, you can move the victim to it — *gently*

Carry the victim to the new site on a litter (you can make one from pack frames)

Treating Profound Hypothermia (con't)

- DO NOT CARRY THE VICTIM ON THE BACK OF ANOTHER PERSON!
- In shelter, there needs to be at least one person with the victim at all times to keep the patient from moving and to provide some warmth from body heat
- When applying body heat, there should be as little clothing between the patient and care-giver(s) as possible

Treating Profound Hypothermia (con’t)

6 — Improve the quality of the shelter you are providing for the patient

A tent will do if nothing better is available

Snow caves or other types of shelters that the wind can’t get through are better

Heat the shelter with more than just body heat

You can use a stove unless you are in a tent or there is a lack of ventilation

Treating Profound Hypothermia (con’t)

- You can heat tents with well-wrapped rocks you have heated in your fire outside
- Body to body contact (under the covers) should to be used to provide warmth to the victim
- (Society’s “rules” versus the need to save a life comes into play …)

Treating Profound Hypothermia (con't)

IF the victim is *not* re-warming after two hours *AND* rescue is distant, added heat should be gently applied to the trunk with heated stones or hot water containers

Wrap the heated objects so they will not burn the patient

7 — Cancel all other plans — a victim of profound hypothermia needs hospital care as soon as possible

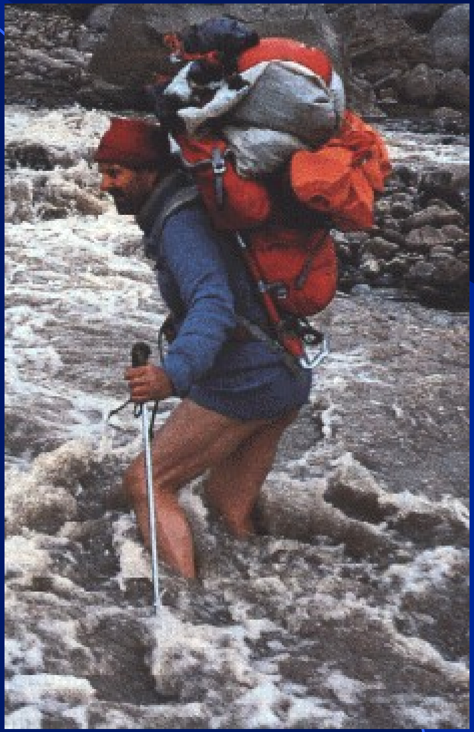
8 — Plan for a rescue and send for help

Treating Profound Hypothermia (con't)

There are some advanced life support measures that are appropriate for field and hospital care of patients with profound hypothermia. However, these skills and techniques should be accomplished only by rescue or hospital personnel who are specifically trained and certified for the necessary procedures. Professional medical personnel who are at least ACLS / ATLS certified may request the version of this presentation that includes a few slides that refer to these techniques

Immersion Hypothermia

- While immersion hypothermia is most often thought of in terms of water-based activities, all of us who are active in the outdoors are vulnerable.
- Will he make it, or will he fall in? Is there a pool behind him? Are there obstacles there that can trap him?
- Are you ready to be dunked in that numbingly cold water?



Immersion Hypothermia

In relation to hypothermia, cold water has two specific threat characteristics:

Extreme thermal conductivity (the rate at which it can conduct heat away from you)

The specific heat of water (the large amount of heat needed to raise water temperature)

These, plus water's ability to penetrate clothing, make immersion hypothermia a potential hazard to outdoor activities

Immersion Hypothermia (con't)

- As in any other outdoor activity, preventing immersion hypothermia is by far the best way to take care of the problem
- You need to prepare yourself to prevent hypothermia relative to the temperature of the water you may fall into and the activity you are taking part in
- Wetsuits are an obvious choice for surfing, board sailing, and whitewater activities

Immersion Hypothermia (con’t)

- Choices are less obvious for such activities as fishing and flatwater canoeing on a warm day
- Be prepared for the worst, and dress for the dunking if conditions make a swim more likely
- Personal floatation devices (PFDs) should be worn for all cold or roughwater activities

Immersion Hypothermia (con't)

- Increase your food intake to match the worst that can happen to you (a swim in cold, rough water will burn a LOT of calories…)
- Never allow yourself to get dehydrated for any reason
- No matter how warm it is above the water, you keep on wearing that PFD! If you get dumped in, it keeps you afloat, and helps slow heat loss from the trunk

Immersion Hypothermia (con't)

- PFDs with large closed cell chest pads, closed with a zip-up front can decrease cooling rates by about 30%
- Well-constructed floatation jackets can decrease heat loss rates by 40%-50%
- Full-body cold weather survival suits can increase predicted cold water survival times by as much as 4-5 times that for unprotected people

Immersion Hypothermia (con't)

- When you are suddenly immersed in cold water, several things happen:
- Blood pressure can rise rapidly due to the constriction of the peripheral blood vessels
- Your heart rate may increase as a result of fear or panic
- People with heart defects or cardiac illness may develop lethal abnormalities

Immersion Hypothermia (con’t)

- Immersion hyperventilation is the first risk…
- The first few seconds of immersion in cold water bring a breathing pattern of deep, involuntary gasps
- This is followed by a minute or more of deep, rapid breaths, with tidal (breathing) volumes about five times normal
- Drowning can easily happen in this early stage, especially if you are plunged deep below the surface, or fall into rough water

Immersion Hypothermia (con’t)

- With hyperventilation comes alkalosis
- You lose larger than normal amounts of carbon dioxide, reducing the blood levels of CO_2, and increasing the blood’s pH
- Physiologic responses to alkalosis cause a reduction in blood flow to the brain
- Dizziness or fainting can result, increasing your chances of drowning

Immersion Hypothermia (con't)

- In water temperatures around 60°F (15°C) you can only hold your breath about a third of the time you normally can — this increases the chances of drowning if you go under the surface for more than a few seconds
- When you hit the water, the peripheral blood vessels constrict immediately, and this forms a body "shell" that helps slow core cooling

Immersion Hypothermia (con't)

- However, there are some problems with this "tissue insulation"...
- As the muscles cool, nerve impulses are slowed, resulting in slow, weak, poorly coordinated movements
- This makes treading water or swimming much more difficult than normal
- Dysfunction increases as the tissues cool, causing inability to swim or tread water after 10-15 minutes in 50°F (10°C) water

Immersion Hypothermia (con’t)

- When this stage is reached (in as little as five minutes in icy water) the victim is no longer able to assist in his or her rescue
- In such cases, a rescuer has to be prepared to enter the water with the victim if the rescue is to succeed
- Hypothermia does not cause deaths early in cold water immersion emergencies — these deaths result from either drowning or cardiac arryhthmias

Immersion Hypothermia (con’t)

- However, most people immersed in cold water survive this initial stage
- If you have the time to exercise the choice, enter cold water as gradually as possible
- *DANGER!* — NEVER dive into cold water!
- Consciously control your breathing, if at all possible, during entry and for the first few minutes afterward, until the feeling of not being able to catch your breath is gone

Immersion Hypothermia (con't)

- After 10-15 minutes of immersion, shivering is constant and obvious to observers
- The emotional reaction to the situation can cause feelings that can't be appreciated until you've "been there, done that"
- At this point the body core has ***NOT*** begun to cool — that starts at the 15-20 minute mark in cold (50°F (10°C)) water
- Shivering may temporarily prevent heat loss in dry air, but not in cold water

Immersion Hypothermia (con't)

- Once the core begins to cool, the rate of cooling depends on the temperature of the water
- Differences in body build have an effect on cooling rates in cold water, with body fat being the main variable
- Generally, doubling the skin fold halves the cooling rate

Immersion Hypothermia (con't)

Water Temperature		Cooling Rate
°F	°C	°C / hr
68	20	0.5
59	15	1.5
50	10	2.5
41	5	4.0
32	0	6.0

Non-exercising adults, light clothing, wearing PFDs

Immersion Hypothermia (con’t)

- Alcohol is a feature of many water mishaps, mainly by increasing the chances of a person accidentally entering the water
- Blood alcohol concentrations below a level of 0.10g/100ml do not significantly affect the rate of cooling
- Higher concentrations result in higher cooling rates as a result of the dilating effect on the peripheral blood vessels

Immersion Hypothermia (con’t)

- Once immersed, swimming is a dangerous choice to make
- An average person who can ordinarily swim well probably will not be able to swim more than 1 km (.062 mi) in 50°F (10°C) water on a calm day
- People who tread water lose heat about 30% faster than people holding still while wearing a PFD

Immersion Hypothermia (con't)

- Any motion you make while you are in cold water takes heat away from you much more quickly than holding still
- Huddling with one or more other people will reduce heat loss rates by about a third, especially if chest to chest contact is maintained
- Holding the top of the PFD in your hands and raising your knees to your chest will also reduce your heat loss rate

Immersion Hypothermia (con't)

- Make every effort to get out of the water
- Even getting only the upper body out of the water greatly reduces the cooling rate
- You may feel colder when you get at least part of yourself out of the water, but research shows that full immersion in cold water produces a much faster rate of core cooling

Immersion Hypothermia (con't)

- A positive attitude and will to survive are very important in cold water immersion incidents
- It will *not* extend survival times beyond those dictated by the water and your body
- It *will* help prevent you from giving up
- Knowledge of how immersion hypothermia works and being prepared will definitely help you to extend your survival time

Afterwords

- There is a LOT to know about hypothermia, how it develops, how to prevent it, how to recognize it in yourself and others, and how to treat it when all else fails
- Hypothermia is one outdoors killer that we can tame
- The amount of knowledge you take away from this presentation and build into your outdoor living will determine how safe you are in the outdoors — or not...

Want to learn more?

We recommend the book, *Hypothermia, Frostbite, and Other Cold Injuries* by Wilkerson, Bangs, and Hayward. You can get this book at many outdoors stores, or you can order it directly from The Mountaineers at:

http://www.cyberspace.com/mtneers

Please forward any questions comments, suggestions for improvement, or requests for correction to:

gaelwolf@ssnet.com